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Spatial Organizing and Distribution of Gas Stations Following Urban Passive Defense Approach (Case Study: Gas Stations of Mashhad Metropolis)

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Abstract

Passive Defense is a set of civilian efforts performed to enhance deterrence, reduce vulnerability, sustain essential activities, promote national stability, and facilitate crisis management against military threats of an enemy. Since in battles, sensitive and critical areas of cities are of paramount importance,it is clear that in military agressions, a large part of threats are focused on cities and their urban facilities and equipment, especially fuel centers. As a result, consideration of passive defense while planning cities has a significant role in reducing the vulnerability of cities and their urban elements as well as facilitating the urban crisis management. It also provides the citizens resistance threshold under possible enemy invasion and natural malicious agents. Hence, this article reviews and analyzes the current situation of gas distribution centers and evaluates their positioning across the city of Mashhad with regard to passive defense approach. However, as far as there is no clear- cut criteria for organizing fuel centers with passive defense approach, the Delphi method is used to select the desired criteria in which on the basis of the final comments of the experts, four critera- performance, access, hazards and security election and spatial organization of the fuel tanks and petrol stations- are analyzed using AHP model and GIS spatial analyzes. Accordingly, it can be said that the assessment of the current status of the urban fuel stations in Mashhad indicates that no area of the city enjoys all measures of passive defense (performance, availability, security, and risks). Likewise, the results indicate that the distribution of these centers in the city are mostly consistent with the factor of access. taking into account all the criteria, it is the North West of Mashhad which has the highest utility than other areas. It is followed by the east of Mashhad and the Northeast and the middle east of the city, respectively. Accordingly, it could be stated that ignoring an efficient design for determining the optimum location of the site construction with a passive defense approach results in an inappropriate and naive spatial distribution of the stations leading to an increased security and environmental risks of the city.

Keywords: *Spatial organization, urban Passive defense, gas stations, Delphi method, AHP model*

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Statement of the problem

An overview of the urban development process in our country shows that cities before importing equipment, new tools and facilities did not have the above- mentioned industrial units. With the advent of industrialization and the arrival of such units to the country, no defensive, secure, and environmental requirements and considerations were met and the consequences of their proximity to the urban housing has not been studied. Hence, following this improper planning, most gas stations were positioned in or beside the cities. With the spatial development of the cities, these units were more and more surrounded with urban structures, and even in some cases, they were located in inappropriate places. On the other hand, it seems that while positioning these centers, no safety standards, and privacy protection has been considered, so given the importance and sensitivity of the issue, along with safety and technical considerations needed in locating them, the most important factor, i.e., their protection against military attacks, should be taken very seriously, too. Thus, according to the radius of destructive power and its impact on the surrounding areas, these centers should be built in places that are both far away from the residential contexts and own the perfect opportunity to be defensive. In this regard, considerations of civil defense in the urban planning will have significant impact on reducing the vulnerability of the cities and their urban elements and will also facilitate their urban crisis management and provide their citizens' resistance threshold in cases of possible enemy invasion and natural malicious forces. In other words, passive defense is consisted of a set of measures, actions, and initiatives that using the tools and conditions and without the use of weapons and even manpower is able to rely on its self- defense mechanism. Such actions will not only enhance defensive power of the set in times of crisis but also it will reduce the consequences of the crisis and provide the possibility of rebuilding the damaged areas with the lowest cost.

In fact, in peacetime, passive defense plans are developed and implemented before performing invasive procedures. Given the opportunity provided to prepare such plans in peacetime, it is essential to reconsider such measures in the context of urban planning. (Movahedi nia, 2009: 23). Now, the main goal of passive defense is securing and reducing the vulnerability of public infrastructure in order to gradually create the conditions for such security. These important measures are taken/ taking place in most countries of the world. If these measures are being planned and designed in the country's development (sustainable development), most of the established infrastructures with be by themselves immune (Reihani, 2011: 25). Given the above- mentioned items, this article intends to analyze the positioning of the urban fuel sites (petrol stations) with a passive defense approach and using the Analytic Hierarchy Process1 and Geographic Information System2.

Research purposes

The macro purpose of research

Identifying and analyzing the current situation of fuel distribution centers and assessing the location of these centers in the city of Mashhad in terms of passive defense approach

The micro purposes

1- Reviewing and analyzing the positioning of the fuel sites in Mashhad and grading the case study in terms of access to these centers

2- Recognizing the importance and potential of geographic information systems (GISs) in locating physical- bodily elements of cities, especially fuel distribution centers.

Research questions

1- Has the spatial organization of fuel stations (gas stations) in the study area taken place according to the criteria of urban passive defense?

2- Has access been regarded as the most important factor in locating the fuel (petrol) stations?

Research Hypotheses

1- It seems that the spatial distribution of the fuel stations (gas stations) in the study area

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has not occurred due to urban passive defense measures.

2- It seems that access has been the most significant factor in positioning the gas stations.

Research Methodology

This applied and practical study has a descriptive- analytic nature and method and its results can be used in decision- making and policy-making processes by the city managers. The required data were gathered through a combination of library and field methods. To achieve this aim and to assess the vulnerability along with the impact of each of these centers, since there was no specific criteria for organizing these fuel centers in accordance with a passive defense approach, first, a questionnaire was drawn up. Then, with the Delphi method and through obtaining the experts' comments in the field of passive defense as well as the urban planning experts, each of the indices,was identified and finally, based on the final opinions of the experts, four criteria- performance, access, security, and risks- were selected. At this stage, after obtaining the opinions and using the hierarchical analysis model, weighting of the criteria and determination of their significance coefficients were investigated. Based on these results, the fuel centers vulnerable to these threats were identified and finally, according to the principles and criteria of Passive defense for each of the identified fuel site, suggestions were presented for reducing their vulnerability.

Theoretical foundations

Definitions and Concepts

Defense

According to etymologists, the word (defense) is composed of two components (de) and (fense). In Persian literature and culture, (pad) or (paad) is a prefix that means anti, contradictory, and after. Whenever it precedes a word, the meaning is reversed, for example, poison and antidote, attack and ati- attack, body nd anti body. The same is true for the word attack meaning fight and enemy (Dehkhoda, 1972: 47). Afshar also has introduced the word (padafand) as an equivalent of defense consisted of things to prevent or defeat the enemy's attack (Sadri Afshari et al., 1998: 259). Ziari has divided defense into active and passive.. In his opinion, active defense is offensive and aggressive operating measures aimed at preventing the advance of the enemy, while passive defense means, using procedures that block the effects of enemy action or reduce its consequences (Ziyari, 1998: 24).

Active defense

Asgharian Jedi has regarded human factor as the key difference between active and passive forms of defense so that active defence is a tool that needs direct management by the human user, and includes having war weapons and prpoper organization, training and management of human forces. Lack of human resource shows the invalidity of the tools (Asgharian Jedi, 1998: 24). Movahedinia believes that passive defense includes direct use of weapons ((Earth-to-air and air-to-air missiles, air defense artillery) and cunter- electronic measures to neutralize or reduce the effects of an enemy's air attacks on its targets (Movahedinia, 2007: 3).

Passive defense

The Expediency Council has also adopted passive defense as a set of non- armed actions taken to increase deterrence, reduce vulnerability, sustain essential activities, promote national stability and facilitate crisis management against military threats of an enemy. As such, efficient Passive defense should be able to provide the basic needs of the population viability and facilitate the social elements for administration of the country in times of crisis (wars) (Reihani, 2011: 18). Based on this definition, 5 purposes of passive defense are:

1.Reducing vulnerability: it is necessary to recognise and reduce the most vulnerable sites. Of course, this is just a relative reduction, not an absolute one, that is, due to lack of advances in technology, it is impossible to reduce the vulnerability rate, yet it can be achieved up to 70%.

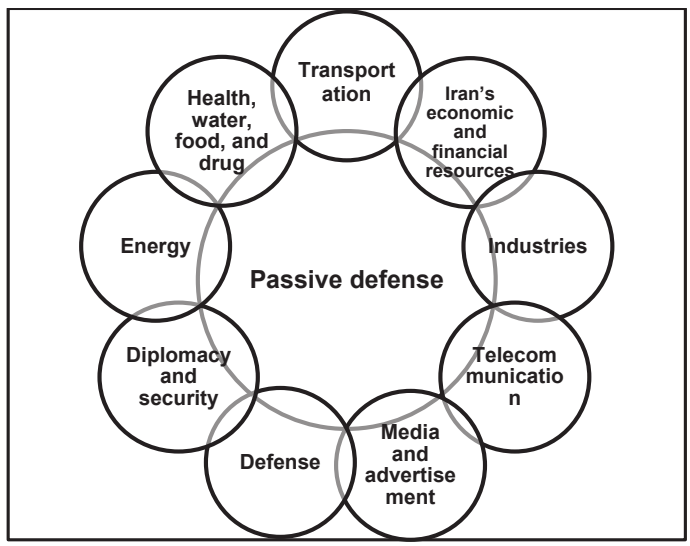
2.Increasing resistance: it is needed to strength-

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en the infrastructure against external threats to maintain their function against them.
3. Producing deterrence.
4. Facilitating crisis management: while facing crises, we should be able to easily manage the state, especially in times of military threat.
5. Providing continuity of essential services: special actions should be taken to offer services to the country
in times of threat and crisis so that people can benefit from services such as water, electricity, health, security, food and so on (The Expediency Council, 2007).
In addition, according to Article 111, Clause 121 of the Fourth Development Plan of passive defense, a set of non-armed actions can reduce the vulnerability of human resources, buildings, facilities, equipment, and arteries of the country whole confronting hostile and destructive actions of an enemy (Parsomash Consulting Engineers, 2010: 102).
Fields of passive defense
The Macro axes affecting the passive defense of in national, regional, municipal levels are provided in the charts:
Passive defense does not involve using weapons. In fact, it can prevent ot reduce the implementation of financial losses to critical military and civilian facilities, human casualties, and the amount of these losse (Movahedinia, 187283: 34). In most scientific and military resources of the world, passive defense issues are consisted of 6 to 7 following measures- camouflage, concealment and deception, cover, and distribution division, retrofitting and fortifications, it is an announcement- which should be considered in designing and planning of administrative measures.

War and passive defense

The fact that human history has always been associated with war is so impressive that it has been accepted as a social phenomenon, so most sociologists have allocated a part of their research on its effects the lives of human beings. .In this regard, passive defense is known as a vital principle. Taking passive defense steps in modern wars to tackle the enemy invasion and reduce damage from ground, air and sea attacks is a fundamental issue whose breadth and scope is covering all key infrastructure, vital centers, critical military and civilian and fuel centers such as refineries, power plants, ports, airports, industrial complexes, bases and military command and political guidance and decision-making centers, the main centers of communications and strategic bridges, military industry, air bases, missile sites, radio and television stations, warehouses of food



Diag 1. Principles of passive defense; Kamran et al., 2011:9

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Considerations	total	civilian casualties	Military casualties	country
Due to far distance of people from the attack scene, it had no civilian .casualties	290000	-	290000 290	.The U.S
nonmilitary lossesdue to air bombardment	500000	100000	400000	England
civilian casualties in death camps	650000	450000	200000	France
of the total 10% population of former U.S.S.R	25600000	12000000	1872600000	Former U.S.S.R
civilian casualties due to air bombardment	7400000	4000000	3400000	Germany
of the total popu- 25% lation of Poland	6000000	5700000	300000	Poland
of the total 10% population of former yugoslovaki	440000	140000	300000	Former Yugoslovaki
	500000	350000	150000	Greece
	8000000	6000000	2000000	China
	3100000	600000	2005000	Japan
	52480000	29240000	23140000	Sum

Table 1. Military and civilian casualties in World War II by country/Passive defense in the light of laws and regulations, 2010

and medicine, population centers and tactical settlements, and preparation and support sites. The experiences gained from past wars., especially eight years of sacred defense, 43-day war in 1991, of the allies forces against Iraq (Persian Gulf War I), 11- week War in 1999 of NATO' against Yogoslavi, the U.S. war against Iraq in 2003, and the recent 33- day war of Israel against Lebonan indicate the fact that the offensive state attacks and bombards the most critical centers to destroy the national will of the citizens and the political, economical, and military power of the state. Taking a research approach to the recorded statistics of the previous wars indicates that because of technological gap between modern weapons of the enemy and the offensive and defensive weapons per se, system vulnerability has increased against electronic warfare, resulting in surprise of this system against aircraft and cruise missiles and ballistic attack, rocket launch from the ultraviolet range, aerial warfare, lack of anti-missile weapons,. Hence, it will endanger its critical objectives in the absence or weakness of passive defense measures changing them into easy targets to manage for quick goals to target and attack by the offensive aircraft and weapons. Today, countries that have tasted the bitterness of failure and damage caused by war have paid especial attention to passive defense to protect their national assets and resources and have granted it priority in their defense strategy.

City and passive defense

Importance of planning Passive Defense for cities

In time of war, cities, as centers of accumulation of material and human capital, will be-

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come the major targets for an enemy to attack and creates a lot of damage. Since the knowledge of passive defense has proved one of its basic functions in case of protecting cities and citizens, taking passive defense measures in architecture and urban planning would reduce man- made threat losses (such as war and aerial bombardment) to reduce the risk of vulnerability against natural hazards. In fact, design integration of passive defense for dealing with natural hazards like earthquakes, in addition to man-made threats, both in times of peace and war, can stabilize its defense plan(Zargar, 187287: 36). There are different approaches in planning passive defense in urban areas which vary greatly in terms of conditions and priority of the type and the execution environment. It is clear thatdespite scientific principles, passive defense which should be performed in cities differes from that of other usages (like refineries and airports) in design and way of running. At the same time, economic decisions, social policies, political strategies and diplomatic imperatives, even in a compressed form, also require their unique manner. In other words, Passive defense measures includes such a precautionary and preventive process that must necessarily begin in peace time and continue to the end of the crisis and the threat. (Ayatollah, 187287: 68).

An overview of the urban development process in the country shows that cities before the introduction of new tools and industrial equipment and facilities were lacking the above industrial units. With the beginning of industrialization and the arrival of such units in the country, in locating most of them, requirements such as defense and security and environmental considerations were not met and the consequences of their proximity to the municipal bodies has not been studied. So many industries, power complexes, refineries, and similar items were built within or near cities. the spatial development of cities were surrounded with the construction of these units over the city and even in some cases, are today located within the urban context.. positioning of complexes and many industries and refinaries in the homogenous level and with other cities of the ciountry is a brilliant sample of unwanted proximity which in times of threat and war, are considered as key tagets by the enemy (ibid: 30).

Hence, it is essential for managers and policymakers to establish such centers preferably at zero and research phases, prior to their construction. It is recommended to consider the characteristics and principles of passive defense and take proper and appropriate measures of defense engineering and land use to reduce the vulnerability of these facilities against possible threats. Moreover, by preserving the infrastructure capital, they can enhance the resistance threshold of the cities. However, recognizing the principles of passive defense and compliance with the principles of urbanism and architecture offers less vulnerability of the urban settlement to factors threatening the urban environment at the time of destructive environmental phenomena or enemy attacks and prevents irreparable disasters against unexpected environmental and man- made phenomena; therefore, prevents it from wasting human and economic resources. (Utopia Consulting Engineers, 2010: 78).

AHP method

AHP is one of the most comprehensive systems designed for decision- making with multicriteria, because it provides the opportunity to formulate the problem in a hierarchy. It is also possible to consider different qualitative and quantitative criteria in the problem. This process involves various options in decisionmaking and offers the possibility of analyzing sensitivity on its criteria and sub criteria. In addition, it is founded on the principles of double comparison which facilitates judgement and calculation. Moreover, it indicates the rate of decision- making which is a unique advantage of this technique in multi- criteria decisionmaking. This technique is based on the following obvious principles:

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1.Reverse condition: If preference of the element A on the element B equals , the preference of the element B on the element A will be.

2.Principle of homogeneity: elements A and B must be homogeneous and comparable. In other words, the priority of the element A over the element B can not be infinite or zero.

3.Principle of dependence: each hierarchical element can depend on its own higher-level element. Linearly, this dependence can be continued up to the highest level.

4.Principle of expectations: Whenever a change occurs in a hierarchical structure, the evaluation process should be re-done.

Analytical Hierarchy Process starts with identifying and prioritizing the elements of decision-making. These elements include purpose, icriteria ot indices, and probable options which are used in priority. The process of identifying the elements and the connections between them which results in a hierarchical structure is called "building hierarchy". Hierarchical nature of the structure in due to the fact that decision-making factors (options and decision- making criteria) can be summarized at various levels.

AHP has five stages, namely:

1-Creating a hierarchy of the studied subject matter

2-Calculating the weights (factor of importance), criteria, and sub-criteria, if any

3-Calculating the weights of the options

4-Calculating the final score of the options

5-Check the logical consistency of the judgments

Using Delphi method to determine passive defense criteria

Delphi approach, a systematic method in research, is used to extract the comments of an expert group about an issue or a question (Landeta.2006.25). it may also cover a group consensus through a series of questionaire rounds with maintaining the anonymity of the respondents and dealswith the opinion feedback to the members of the panel (Rowe.1999.1872). Applying professional judgments of the homogeneous and independent expert on a special topic is performed in large geographical area using the questionairs. It is repeated till the access time to the group concencus (nurses, 2003, 3). Multi- phase research method is used for gthering comments on subjectivity of the issue and using written answers instead of bringing together an expert group; hence, the purpose of integration is obtained with the possibility of free expression of ideas and with the review of the comments with the numerical estimates (McKenna..2002,45).

Terms of use

The most important requirement for using Delphi is the need to judge the opinions of a broad group of experts, to achieve collective agreements while reaching to the results, presence of complex, large, and interdisciplinary problem, and disagreement or incomplete knowledge, the availability of professionals with experience and expertise which are geographically dispersed. It indicates the need for anonymity in data collection,with no time limitation and no other cost- efficiency method (Salsali , 2003,15).

Research findings

Weighting the positioning indices

According to the experts in the field of passive defense and the field of urban planning and by using the Delphi method for each of the criteria and sub-criteria, they were weighted according to their importance. In this situation, each layer has a maximum weight that can affect the optimal location. In the weighting method, first, specific weighted values are defined for the number of indices. For example, if four criteria are considered, the numbers 1 through 4 are regarded for weighting, where 4 stands for the largest weight (the most important) and 1for the lowest weight (the least important). Then, the weights to each of them are averaged and each is divided by the average. In the next step, each of the numbers obtained in the column is divided by the average of the sum of this column and put in the final weight column. The final weight of the indices is in fact

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Total weight	Divided by average	weight	subcriteria	criteria	
0.23	1.78	8	residential	Nonhomogenous(0.67)	Operational(0.3)
0.1	0.67	3	business		
0.14	0.89	4	Educa-tional		
0.1872	0.44	2	Cultural		
0.06	0.22	1	Religious		
0.14	1.11	5	Industries		
0.2	1.33	6	Terminals		
Total weight	Divided by average	weight	subcriteria	homogenous(0.33)	
0.17	0.5	1	Green space		
0.33	1	2	Sanitary		
0.50	1.5	3	Equip-ment		
Total weight	Divided by average	weight	subcriteria	Access- relational (0.1)	
0.67	1.33	2	Primary arterial		
0.33	0.67	1	Secondary arterial		
Total weight	Divided by average	weight	subcriteria	Hazards(0.2)	
0.67	1.33	2	Natural risk		
0.33	0.66	1	Population density		
Total weight	Divided by average	weight	subcriteria	Security(0.4)	
0.33	0.66	1	decentral-ization		
0.67	1.33	2	Far from down-town		

Table 2.Criteria and sub criteria of positioning fuel centers with passive defense considerations, Drawn by authors

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Total weight	Divided by average	weight	subcriteria	Total weight	Divided by average	weight	subcriteria
0.67	1.33	2	Non homogenous uses	0.3	1.2	3	performance
0.33	0.67	1	Homogenous uses	0.1	0.4	1	relational
				0.2	0.8	2	risks
				0.4	1.6	4	defense

Table3. Weighing positioning parameters, Drawn by authors

a normal weight which determines how important the indicators are for each other on equal terms; hence, the sum of the final weights is 1. Tables 1-3 and 2-3show the weight of the criteria and the sub criteria for each subject.

Scrutiny of desired indices in locating fuel centers with passive defense approach

Correct locating of the uses and preserving their privacy can greatly reduce the damage caused by possible attacks. Considering the principles of locating in land-use planning is very important. However, it can be inferred that in preparation and adoption of comprehensive and detailed plans passed by the Supreme Council for Planning and Architecture of Iran, no clear criteria is defined on user location with passive defense approach. Here, only on the basis of a mathematical model, the population growth and the provision of services for different uses, typically prepared the councellors, will suffice. In general, it can be said that in most cases, the ease of access to services is taken into accounts as the main criteria. Hence, although passive defense lacks clear- cut parameters, in this research, the fuel centers are evaluated in terms of four indices: access, performance, natural or synthetic risks, and security.

Performance indicator

Performance measure merely deals with defining the civil defense in the field of urban planning and urban land use. It also defines those uses suitable for proximity with fuel centrers as compatible land uses and those lands that are in conflict with the fuel centers as inconsistent uses (Ismaili Shahrokht, 2010: 45). Next, the desired indicators used in these criteria as well as the way of their distribution in the city of Mashhad is: presented:

Incompatible land uses

- Residential

Residential distribution per unit area across Mashhad mostly is centralized in the eastern and north-eastern areas indicating the high population density in this area, so the components are fine-pitched. In the middle and mid-west areas of the city, due to low population density and land allocation to non-residential use, the residential use concentration is lower.

- Business

More commercial distribution is seen in the central areas and in the peripheral tissues of the holy shrine and Martyrs' Square. Meanwhile, in the north-west, around the corridors of Tous And Cento, several areas of significant commercial uses are seen.

- Training

Distribution of educational facilities in the city of Mashhad is partly a function of the distribution of the resident population so that the highest distribution is observed within the North East and the West of the city.

- Cultural

Cultural use is focused across the range the central and the western parts of the city.

- Religious

This type of use is centralized in the central parts of Mashhad. It is because of the presence of the holy shrine of Razavi as well as its surrounding mosques and Takaya.

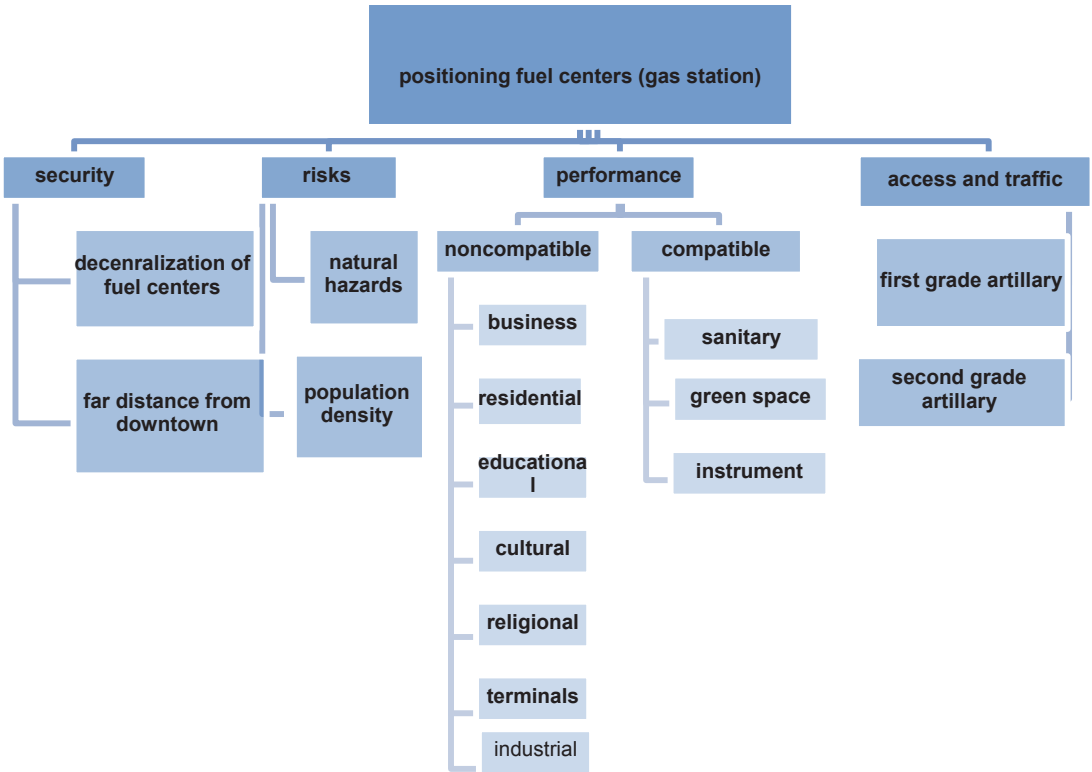
- Industrial use

This kind of use is distributed focusedly in Mashhad so that two centralized areas are seen far apart from each other. The most important area in terms of centralization is the northeast areas of Mashhad, around the Cento and Tous axes which is regarded as the biggest industrial area in urban and infraurban scales.

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- Transport, storage and urban terminals
transport and storage uses are centralized in the central parts of the city and in the area surrounding the shrine.
- green space
The establishment of green space is centralized in the central area and some northwestern parts of the city of Mashhad.
- Health
Health Uses are concentrated in the central and the western regions of Mashhad, it is because of the presence of coarse and close grains in these areas.
- Urban equipment
Urban equipment use is centralized mostly in the central and the western regions.
Access Index
Since the establishment of alternative systems damaged in emergency situations is essential, while designing the street network of a city, the item of multiple access should be predicted. Moreover, the presence of the detours is essential especiallyat times of traffic as an appropriate policy to provide relief services to the affected areas. The more the number of unified streets, the more the options for evading. Street width and their cross sections are also significant issues related to civil defense which should be considered while constructing and designing the main networks with great width. The minimum passage width must be such that if there is falling debris, it should not prevent rescue and relief forces from reaching the rescue equipment. In fact, the available width should at least be enough to pass a car, safe from falling debris (NaghshAzar Consulting Engineers, 2009: 5). Accordingly, the access is divided into primary and secondary arterial roads which are briefly descried in the following section:
- Primary arterial pass: these paths provide connection the suburban network . By applying different levels of access control, these primary ways are classified as freeway, highway and passageway:
- Freeway: a path that in its entire length, traffic is physically separated in both sides, and the uninterrupted traffic flow (free) is observed and there is no level crossings (www.roshd.ir).
- Highway: a road in which the traffic on both sides is physically separated and in its substantial lengths, a continuous flow of traffic can be considered. Highways can have a few level crossings, provided that the distance intersections of each lot is great (more than about 2.5 km). (www.roshd.ir).
- Passageway: the rest of the suburban bilateral roads often continues in small and medium towns or villages, in case that they pass performance within the town or village is also preserved. The distance between level intersection roads is not less than about 2.5 km. (www.roshd.ir).
-Secondary Arterial roads
Grade 2 arterial road is a way that is preffered mostly for design and operation of the mobility and accessibility of motor vehicles. To follow this preference, the pedestrian movement is controlled across the street. Grade 2 arterial roads have an interurban function and the main network creates the intracity roads(www.roshd.ir). In the maps allocated to access rate to the main and side passages, especial districts are considered in equal distances, so that getting far away from the district, less access is provided to the main and side passages.
Risks
Iran is known as a land which is always subject to various natural and synthetic risks. Iran's unique geopolitical and geostrategic position, availability of vast underground resources and the formation of an ideological regime have caused the country face various external threats and conflicts (Rajabipour, 187287). Therefore, these risks are divided into two categories: natural and population density hazards which are discussed separately:
- Natural hazards: it refers to disasters caused by floods, earthquakes, and subsidence which based on the relevant map, are mostly observed in the western and the mid-western regions as the highest probability of risk.
- Population density: population density in the

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Graph 2. Positioning parameters of fuel centers (gas stations)

city of Mashhad, is seen in the North East and in areas where informal settlements are focused. It should be noted that in this study, "resident population" is considered and the non-resident population who commute during the year are ignored.

Security

Urban regions which consist 65-90% of the economical activities in most Asian countries are most vulnerable to damage in case of sudden danger or threat. Whenever a factor is threatening the security of cities, it should be regarded as the backbone of economic- based activities to made them survive and on the other hand, it should provide opportunities for a great number of people to adapt themselves with the new condition, since in near future, by 2030, two thirds of people living on the earth will live in urban areas. The rapid and undisciplined growth of cities have made the cities to face major risks (Naghsh Mohit consulting engineers, 2010:128). The security index in the present study is analyzed with a focus on two sunindices: centralization of gas stations and their distance of the citycenters:

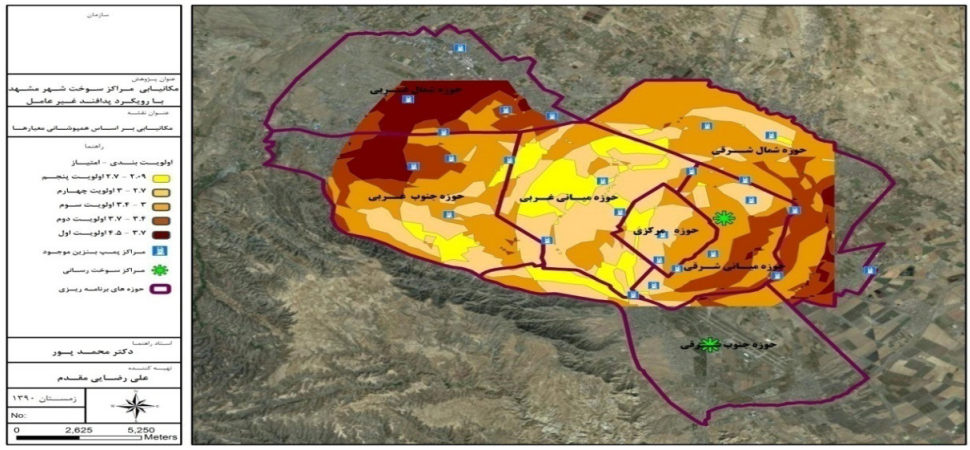
- Concentration of gas stations: now, the gas stations are centralized in the central and the western regions of Mashhad. Under the new positioning of the fuel stations (petrol stations), distribution is considered over zones that are not prone to focus.

- Far from downtown: in the city of Mashhad which is a single-center city, the high daily population density in the textures surrounding the shrine and Martyrs' Square and the area between these two is considered. On the other hand, positioning the fuel centers within such areas or close to them, in terms of safety and civil defense measures, is unacceptable. According to the map, in terms of user load petrol stations, zones away from downtown are more susceptible.

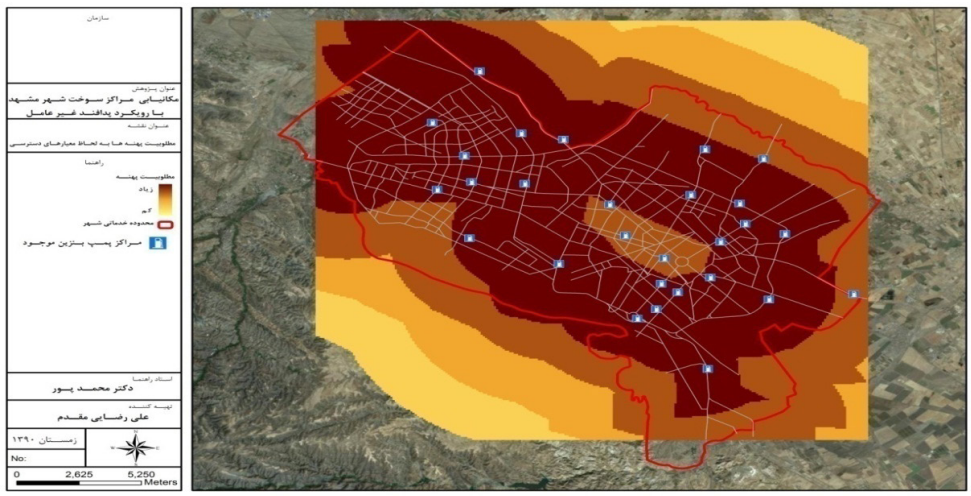
Research findings

It seems that spatial positioning of fueling stations (gas station) in the study area has not taken place in accordance with the urban pas-

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Map 1. Locationing based on criteria overlap; (Drawn by authors)



Map 2. Overlaying the "performance", "access", "risk" and "passive defense"

sive defense measures. Analysis of the passive defence parameters (access, performance, risks, and security) individually and as a whole showed that no area in Mashhad has been granted all passive defense parameters just due to desirability; however, the North west of Mashhad had better situation than other areas of the city. It was followed by the East Mashhad as the second priority and the third priority was given to the Northeast and East middle areas. It is worth noting the last priority was given to the mid- western areas (the fifth priority). Accordingly, the desired hypothesis will be proven.

It seems that the most important criteria for selection of operating fuel stations is availability factor. This parameter analyzed the primary and secondary main paths positioing the fuel sites. The results showed that among all indices, access played to the most important role in locating fuel stations (petrol stations).so, the proposed hypothsis is proven true.

Conclusion and Recommendations

With regard to potential threats and risks in terms of location (near the eastern border province of Khorasan Razavi province, and the establishment of trans-regional forces against the neighboring countries), there is evident need for rational defense, so applying the principles and criteria of effective urban effective passive defense increases the territorial integrity and national security as well as sustain-

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able development in Mashhad. Accordingly, it can be said that passive defense is a set of non- armed actions that enhance deterrence, reduce vulnerability, sustain essential activities, strengthen national stability, and facilitate crisis management and military threats of the enemies. Since critical regions of the cities are very important during wars, it is clear that in case of military attacks, most threats are aimed at the city and its available tools and facilities including the gas stations. As a result, considerations of the passive defense planning plays a significant role in reducing the vulnerability of cities and urban elements and facilitates urban crisis management and citizen resistance threshold in terms of possible enemy invasion and natural malicious agents. Accordingly, positioning these centers is very important. Nevertheless, because there has been no criterion for site selection of the fuel centers with passive defense approach, the Delphi method was used to select the desired criteria. It was conducted on the basis of the final comments of the experts including 4 criteria- access, performance, risks, and security. The positioning process of the fuel stations was performed using AHP model and GIS.

With the assessment of the current situation of these gas stations in Mashhad, it can be said that no area of the city has all passive defense criteria (access, performance, risks, and security). The results show that they are distributed based on access factor and just the northwest area of the city with considering all parameters has the highest rate of desirability. It is followed by the eastern area of the city and the north east and Mideast areas. Need to note that the mid- west area has the last preference (the fifth) in which the density of the gas stations is very low. The studies showed that the presence of two gas stations in the city which were designed without considering the passive defense parameters are very dangerous for the city, since they increase the vulnerability of the residential areas and are close to the railroad station and the holy shrine of Imam Reza. Hence, it can be inferred that ignoring an elite plan for determining the optimal position of such sites with a passive defense approach leads to improper and uneven spatial distribution of the stations and creates numerous problems for the city.

Next, several suggestions are offered in case of positioning fuel stations considering a passive defense outlook:

1- Comprehensive and clear definition of passive defense in preparation and adoption of comprehensive and detailed plans

2- formulation of standards and regulations codified to show precise location of gas stations (petrol stations) with passive defense approach

3- Staying away from the center of the city. since the city of Mashhad is a single-center city, the daily high population density in Martyrs' Square and the surrounding texture of the shrine and Martyrs' square indicate this region. Making fuel centers within this area or close to them, in terms of safety and civil defense measures, is not acceptable.

4- Transfer of fuel centers outside of the urban settlements to avoid risks.

5- It is proposed that considering a decentralization policy for those utilities such as fuel centers in which presence is not necessary for the municipal body, can increase the relative safety of cities and reduce their vulnerability factor.

6- It is wise for the managers and policy officials to manufacture, construct, and develop centers, by adopting appropriate measures, preferably at zero and research phases and studies before building and constructing. By considering the characteristics and principles of passive defense measures and adopting appropriate measures and defense engineering Land use planning, the center's vulnerability in the face of possible threats to the preservation of capital reduction and infrastructure increases, so cities try to promote their resistance threshold.

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